

## CLAIMS

1. A semiconductor device comprising:

an insulation film formed on a substrate;

a buried wire formed in the insulation film; and

5 a barrier metal film formed between the insulation film and the buried wire,

wherein the barrier metal film is formed of a metal oxide film, a transition layer and a metal film stacked in this order in the direction from a side of the barrier metal film at which the insulation film exists to a side thereof at which the buried wire exists, and

10 wherein the transition layer is formed of a single atomic layer having substantially an intermediate composition between respective compositions of the metal oxide film and the metal film.

2. The semiconductor device of claim 1, wherein a metal forming the metal oxide film and a metal forming the metal film are different elements.

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3. The semiconductor device of claim 1, wherein a metal forming the metal oxide film and a metal forming the metal film are the same element.

4. A semiconductor device comprising:

20 an insulation film formed on a substrate;

a buried wire formed in the insulation film; and

a barrier metal film formed between the insulation film and the buried wire,

wherein the barrier metal film is formed of a metal oxide film, a transition layer and a metal film stacked in this order in the direction from a side of the barrier metal film at

25 which the insulation film exists to a side thereof at which the buried wire exists, and

wherein the transition layer is formed of a plurality of atomic layers having substantially an intermediate composition between respective compositions of the metal oxide film and the metal film.

5           5. The semiconductor device of claim 4, wherein a metal forming the metal oxide film and a metal forming the metal film are different elements.

6. The semiconductor device of claim 4, wherein a metal forming the metal oxide film and a metal forming the metal film are the same element.

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7. A semiconductor device comprising:

an insulation film formed on a substrate;

a buried wire formed in the insulation film; and

a barrier metal film formed between the insulation film and the buried wire,

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wherein the barrier metal film is formed of a transition layer and a metal film stacked in this order in the direction from a side of the barrier metal film at which the insulation film exists to a side thereof at which the buried wire exists, and

wherein the transition layer is formed of a single atomic layer including a metal oxide and a metal forming the metal film and having substantially an intermediate  
20 composition between respective compositions of the metal oxide and the metal film.

8. The semiconductor device of claim 7, wherein a metal forming the metal oxide and a metal forming the metal film are different elements.

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9. The semiconductor device of claim 7, wherein a metal forming the metal oxide

and a metal forming the metal film are the same element.

10. A semiconductor device comprising:

an insulation film formed on a substrate;

5 a buried wire formed in the insulation film; and

a barrier metal film formed between the insulation film and the buried wire,

wherein the barrier metal film is formed of a transition layer and a metal film stacked in this order in the direction from a side of the barrier metal film at which the insulation film exists to a side thereof at which the buried wire exists, and

10 wherein the transition layer is formed of a plurality of atomic layers including metal oxide and a metal forming the metal film and having substantially an intermediate composition between respective compositions of the metal oxide and the metal film.

11. The semiconductor device of claim 10, wherein a metal forming the metal  
15 oxide and a metal forming the metal film are different elements.

12. The semiconductor device of claim 10, wherein a metal forming the metal oxide and a metal forming the metal film are the same element.

20 13. A semiconductor device comprising:

an insulation film formed on a substrate;

a buried wire formed in the insulation film; and

a barrier metal film formed between the insulation film and the buried wire,

wherein the barrier metal film contains oxygen as a component element, and

25 wherein a concentration of oxygen contained in the barrier metal film continuously

varies in a film thickness direction of the barrier metal film.

14. A method for fabricating a semiconductor device, the method comprising the steps of:

- 5       forming a recess portion in an insulation film provided on a substrate;
- forming a barrier metal film including a metal oxide film, a transition layer and a metal film stacked in this order so that the barrier metal film covers surfaces of the recess portion; and
- forming a buried wire on the barrier metal film so that the recess portion is filled,
- 10       wherein the step of forming the barrier metal film includes the step of performing a single cycle of deposition by atomic layer deposition, thereby forming the transition layer of a single atomic layer having substantially an intermediate composition between respective compositions of the metal oxide film and the metal film.

- 15       15. The method of claim 14, wherein a metal forming the metal oxide film and a metal forming the metal film are different elements.

16. The method of claim 14, wherein a metal forming the metal oxide film and a metal forming the metal film are the same element.

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17. A method for fabricating a semiconductor device, the method comprising the steps of:

- forming a recess portion in an insulation film provided on a substrate;
- forming a barrier metal film including a metal oxide film, a transition layer and a
- 25   metal film stacked in this order so that the barrier metal film covers surfaces of the recess

portion; and

forming a buried wire on the barrier metal film so that the recess portion is filled,

wherein the step of forming the barrier metal film includes the step of performing a plurality of cycles of deposition by atomic layer deposition, thereby forming the transition  
5 layer including a plurality of atomic layers having substantially an intermediate composition between respective compositions of the metal oxide film and the metal film.

18. The method of claim 17, wherein a metal forming the metal oxide film and a metal forming the metal film are different elements.

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19. The method of claim 17, wherein a metal forming the metal oxide film and a metal forming the metal film are the same element.

20. A method for fabricating a semiconductor device, the method comprising the  
15 steps of:

forming a recess portion in an insulation film provided on a substrate;

forming a barrier metal film including a transition layer and a metal film stacked in this order so that the barrier metal film covers surfaces of the recess portion; and

forming a buried wire on the barrier metal film so that the recess portion is filled,

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wherein the step of forming the barrier metal film includes the step of performing a single cycle of deposition by atomic layer deposition, thereby forming the transition layer made of a single atomic layer including a metal oxide and a metal forming the metal film and having substantially an intermediate composition between respective compositions of the metal oxide and the metal film.

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21. The method of claim 20, wherein a metal forming the metal oxide and a metal forming the metal film are different elements.

22. The method of claim 20, wherein a metal forming the metal oxide and a metal forming the metal film are the same element.

23. A method for fabricating a semiconductor device, the method comprising the steps of:

forming a recess portion in an insulation film provided on a substrate;

10 forming a barrier metal film including a transition layer and a metal film stacked in this order so that the barrier metal film covers surfaces of the recess portion; and

forming a buried wire on the barrier metal film so that the recess portion is filled,

wherein the step of forming the barrier metal film includes the step of performing a plurality of cycles of deposition by atomic layer deposition, thereby forming the transition  
15 layer including a plurality of atomic layers made of a metal forming a metal oxide and the metal film and having an intermediate composition between respective compositions of the metal oxide and the metal film.

24. The method of claim 23, wherein a metal forming the metal oxide and a metal forming the metal film are different elements.

25. The method of claim 23, wherein a metal forming the metal oxide and a metal forming the metal film are the same element.

26. A method for fabricating a semiconductor device, the method comprising the

steps of:

forming a recess portion in an insulation film provided on a substrate;

forming a barrier metal film containing oxygen as a component element so that the barrier metal film covers surfaces of the recess portion; and

5 forming a buried wire on the barrier metal film so that the recess portion is filled,

wherein the step of forming the barrier metal film includes the step of forming the barrier metal such that a concentration of oxygen contained in the barrier metal film continuously varies in a film thickness direction of the barrier metal film.